



US009171669B2

(12) **United States Patent**
Grossbach et al.

(10) **Patent No.:** **US 9,171,669 B2**
(45) **Date of Patent:** **Oct. 27, 2015**

(54) **ULTRA-WIDEBAND ASSEMBLY SYSTEM
AND METHOD**

(2013.01); **H01F 27/06** (2013.01); **H01P 5/087**
(2013.01); **H01F 2005/006** (2013.01); **H01G**
4/40 (2013.01); **H04B 1/71635** (2013.01);
H05K 1/0243 (2013.01); **Y10T 29/4902**
(2015.01); **Y10T 29/49071** (2015.01)

(71) Applicant: **American Technical Ceramics Corp.**
Huntington Station, NY (US)

(72) Inventors: **Robert Grossbach**, Commack, NY
(US); **John Mruz**, East Northport, NY
(US)

(58) **Field of Classification Search**
USPC 29/605, 602.1; 336/67; 361/782
See application file for complete search history.

(73) Assignee: **American Technical Ceramics Corp.**,
Huntington Station, NY (US)

(56) **References Cited**

U.S. PATENT DOCUMENTS

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 455 days.

8,350,655	B2 *	1/2013	Dobbs	336/130
2004/0004527	A1 *	1/2004	Geller et al.	336/225
2007/0164843	A1 *	7/2007	Yagisawa et al.	336/83

* cited by examiner

(21) Appl. No.: **13/749,129**

(22) Filed: **Jan. 24, 2013**

Primary Examiner — Andargie M Aychillhum

(65) **Prior Publication Data**

US 2013/0199029 A1 Aug. 8, 2013

(74) *Attorney, Agent, or Firm* — Mintz Levin Cohn Ferris
Glovsky and Popeo, P.C.

Related U.S. Application Data

(60) Division of application No. 13/100,521, filed on May
4, 2011, now Pat. No. 8,379,405, which is a
continuation-in-part of application No. 12/080,646,
filed on Apr. 4, 2008, now Pat. No. 8,072,773.

(57) **ABSTRACT**

An ultra-wideband assembly is provided. The assembly includes a non-conductive tapered core having an outer surface, a proximate end and a distal end being larger than proximate end. The assembly includes a conductive wire having a proximate end and a distal end and being wound about at least a portion of the non-conductive tapered core. The proximate end of the conductive wire extends away from the proximate end of the tapered core and is being conductively coupled to a micro-strip line of a circuit board. The distal end of the conductive wire extends away from the distal end of the tapered core. The conductive wire contacts at least a portion of the outer surface of the non-conductive tapered core. The assembly includes a supporting bracket coupled to the non-conductive tapered core. The supporting bracket is configured to dispose the non-conductive tapered core at a predetermined angle to the circuit board.

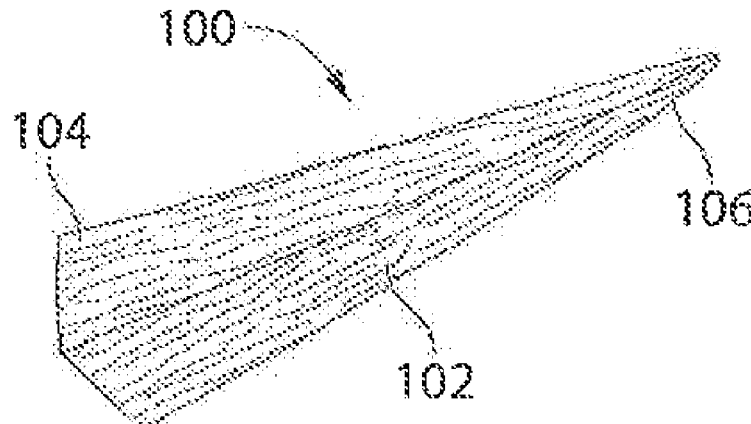
(51) **Int. Cl.**

H05K 7/00	(2006.01)
H01F 41/06	(2006.01)
H01F 17/04	(2006.01)
H01F 27/06	(2006.01)
H01P 5/08	(2006.01)
H01F 5/00	(2006.01)
H01G 4/40	(2006.01)
H04B 1/7163	(2011.01)
H05K 1/02	(2006.01)

(52) **U.S. Cl.**

CPC **H01F 41/0612** (2013.01); **H01F 17/04**

18 Claims, 15 Drawing Sheets



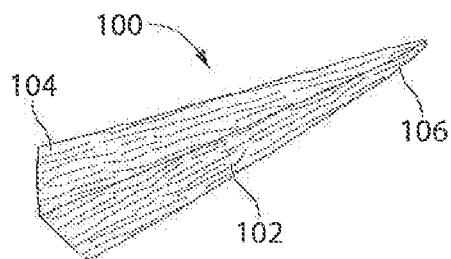


Fig. 1A

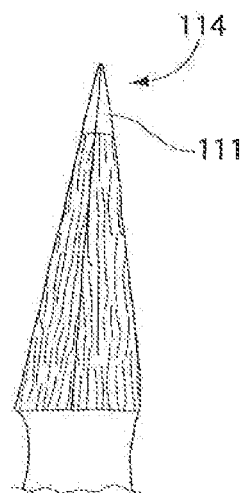


Fig. 1B

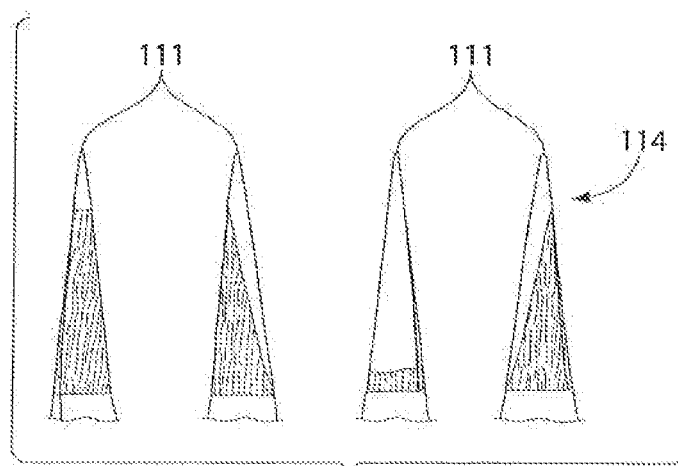


Fig. 1C

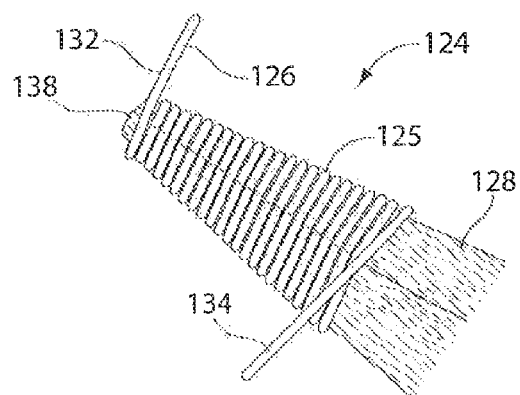


Fig. 1D

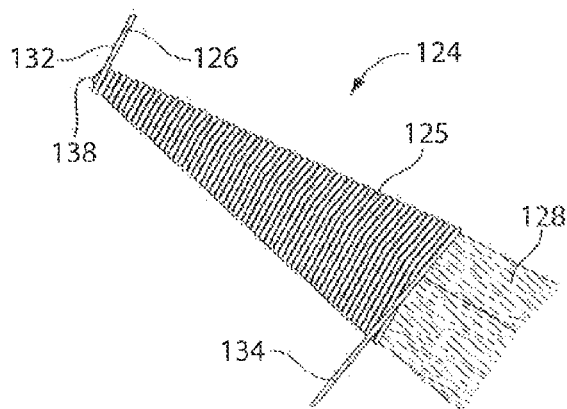


Fig. 1E

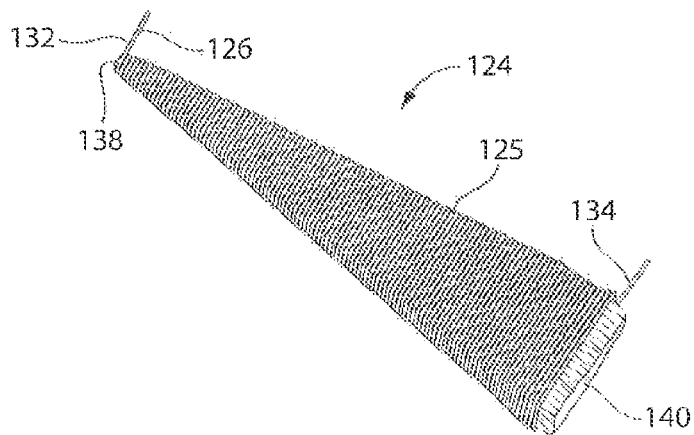


Fig. 1F

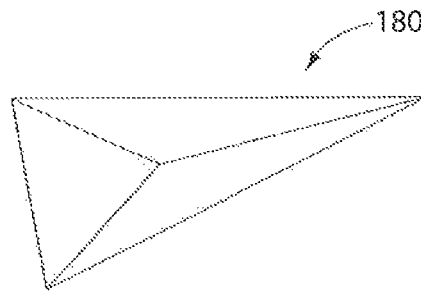


Fig. 1G

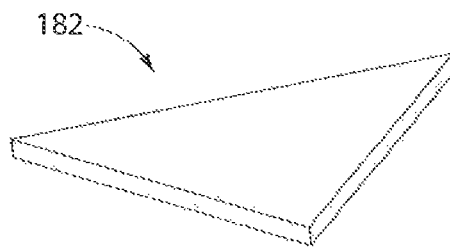


Fig. 1H

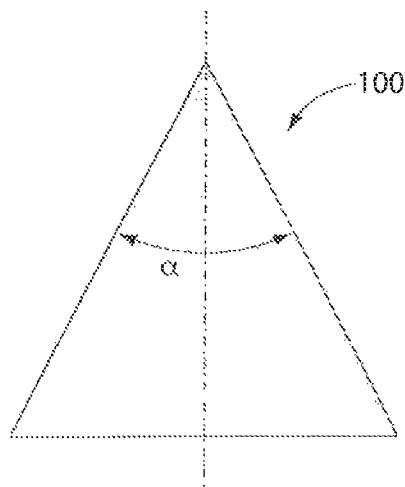


Fig. 1I

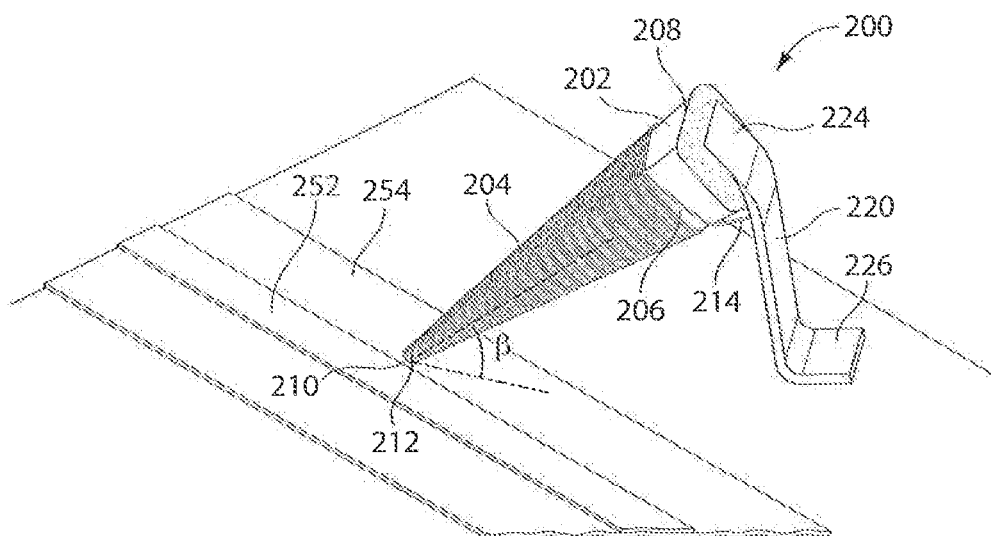


Fig. 2A

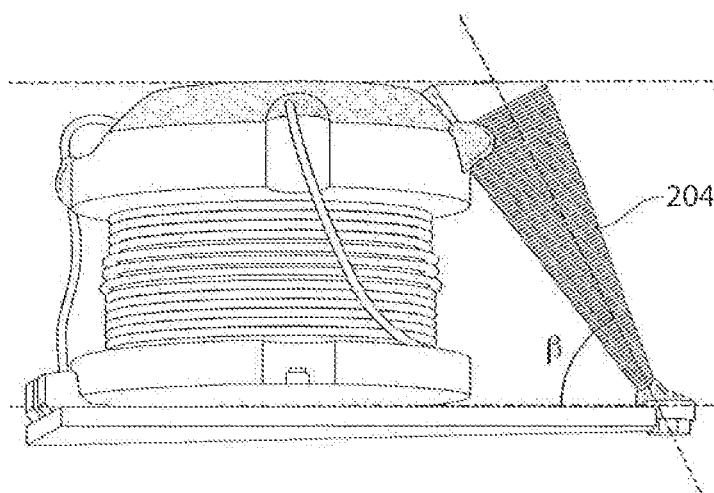


Fig. 2B

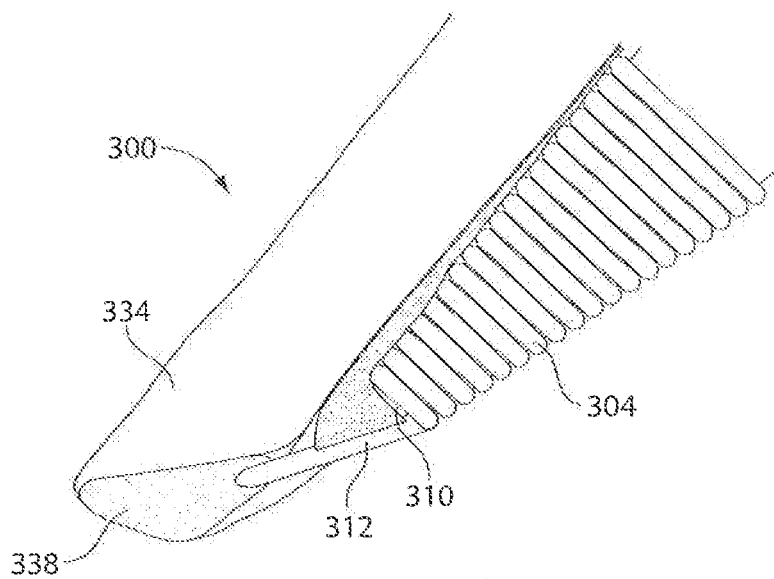


Fig. 3A

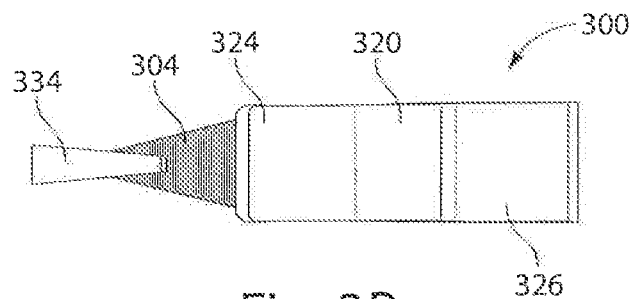


Fig. 3B

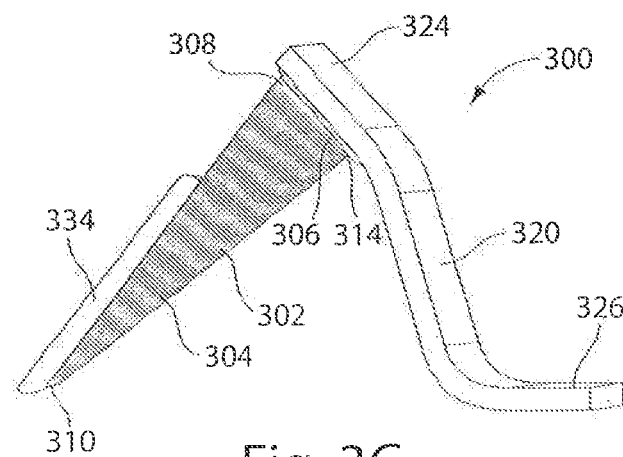


Fig. 3C

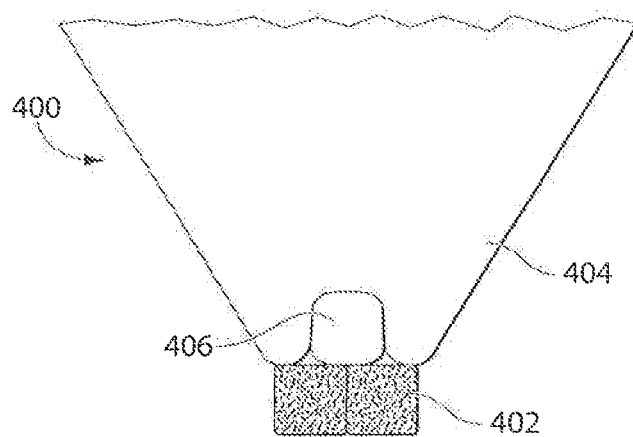


Fig. 4A

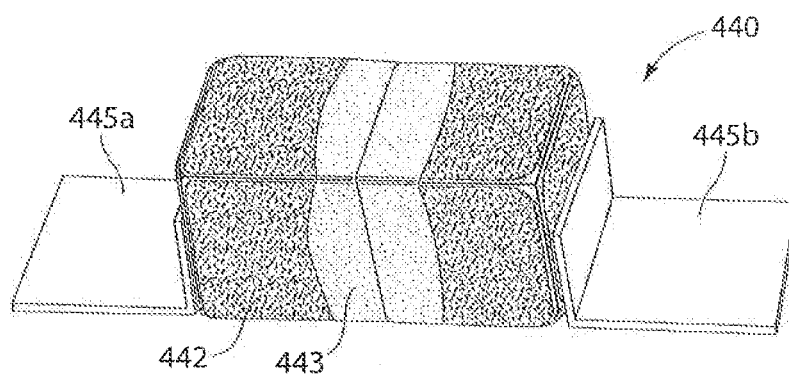


Fig. 4B

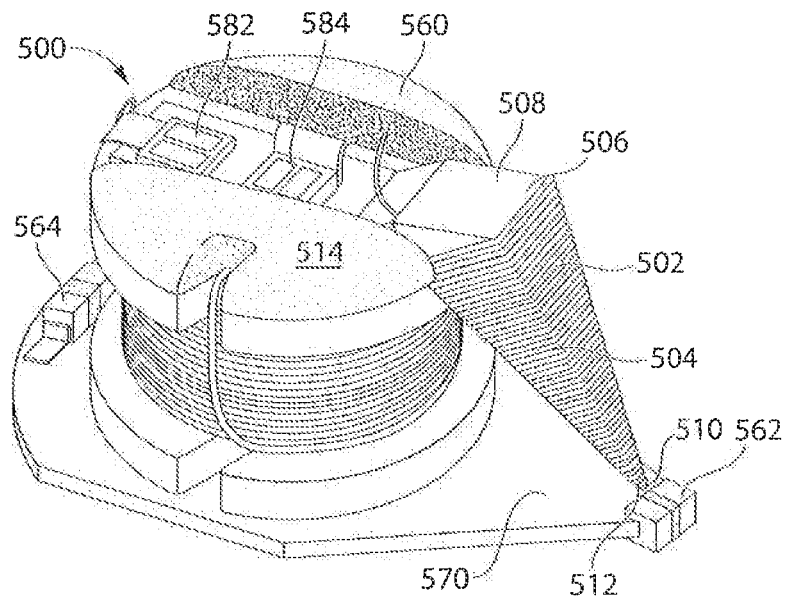


Fig. 5A

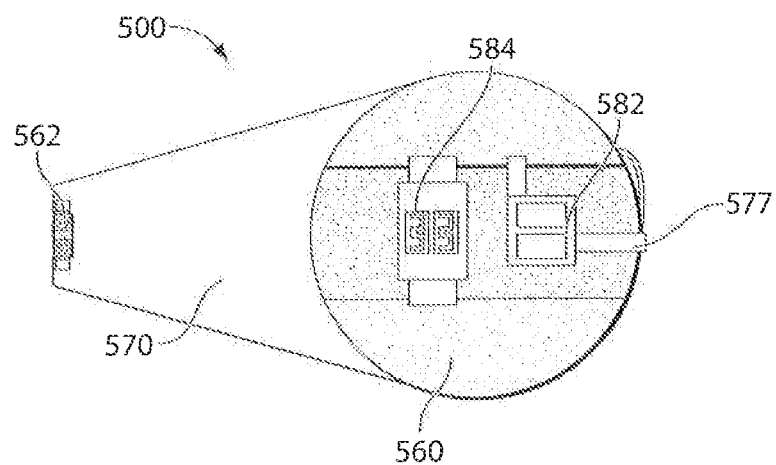


Fig. 5B

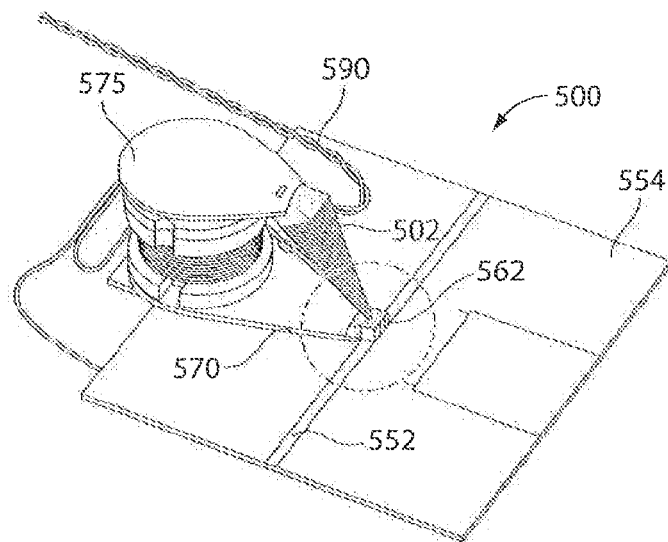


Fig. 5C

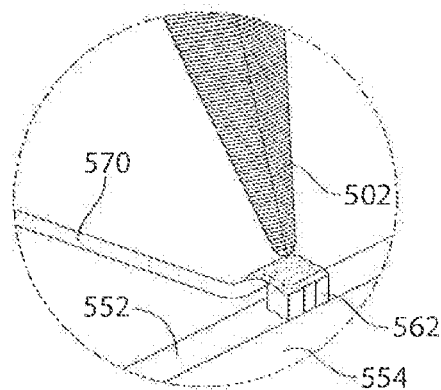


Fig. 5D

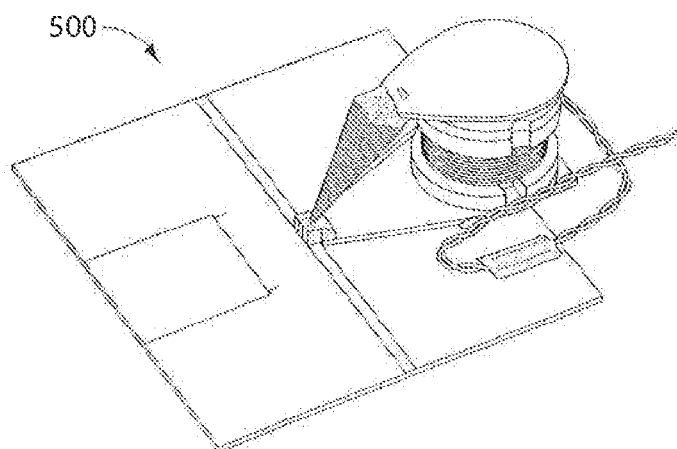


Fig. 5E

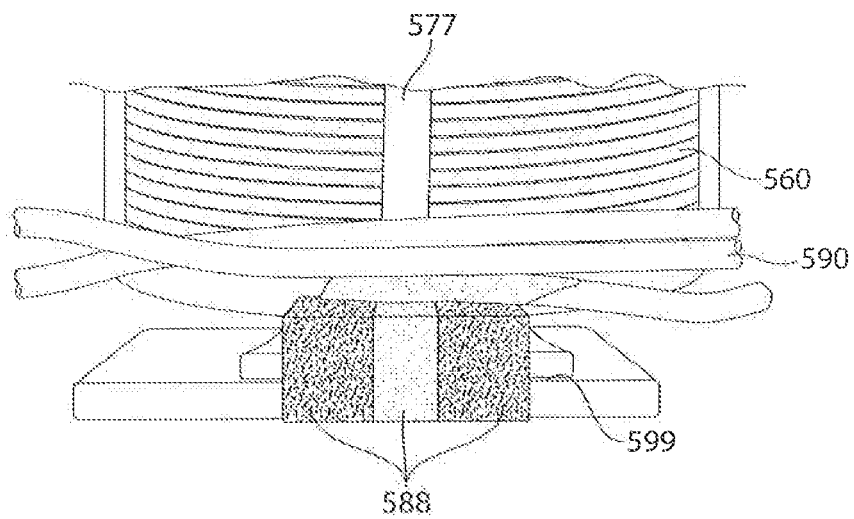


Fig. 5F

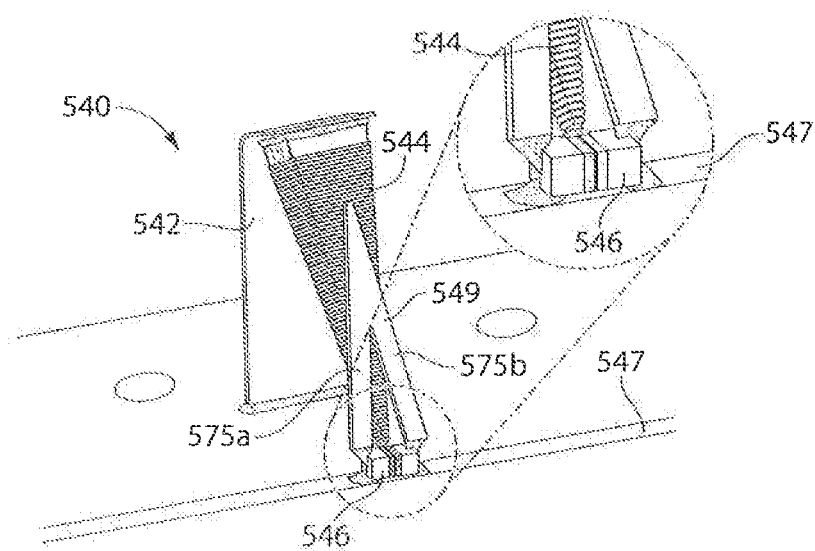


Fig. 5G

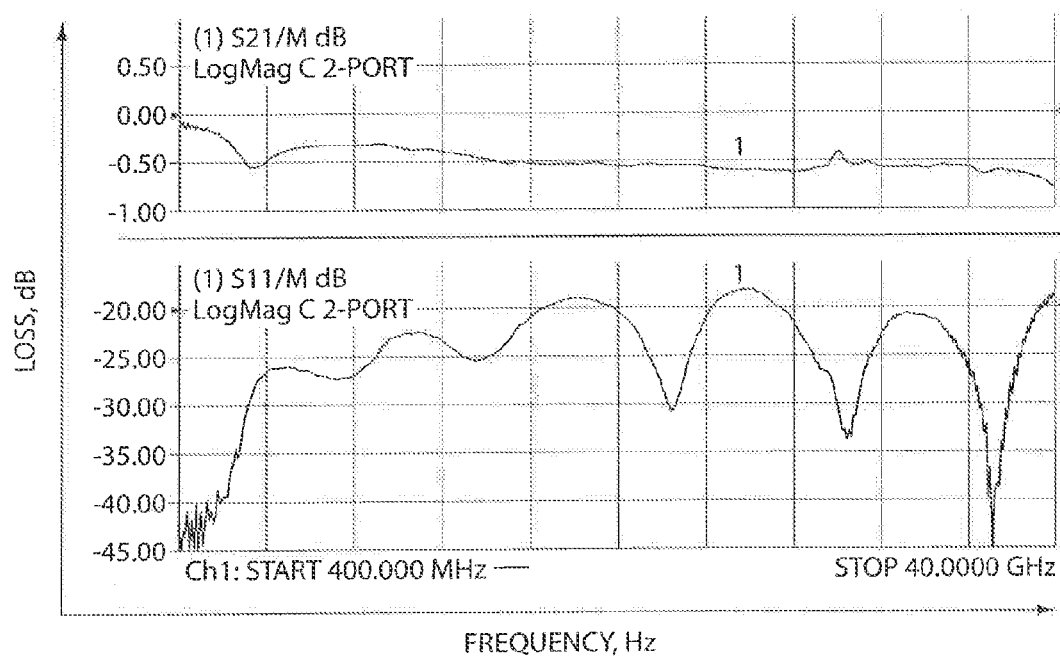


Fig. 6

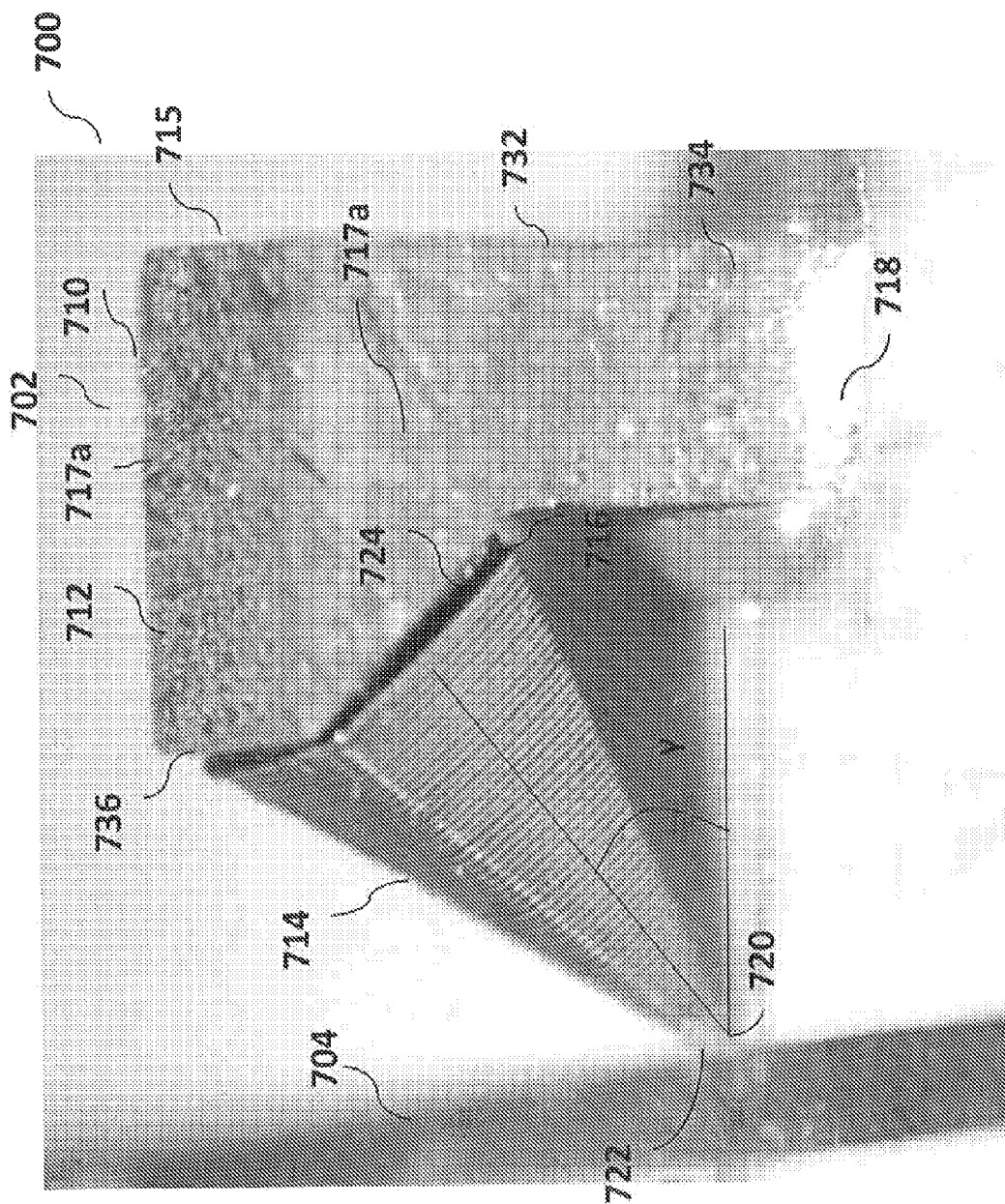
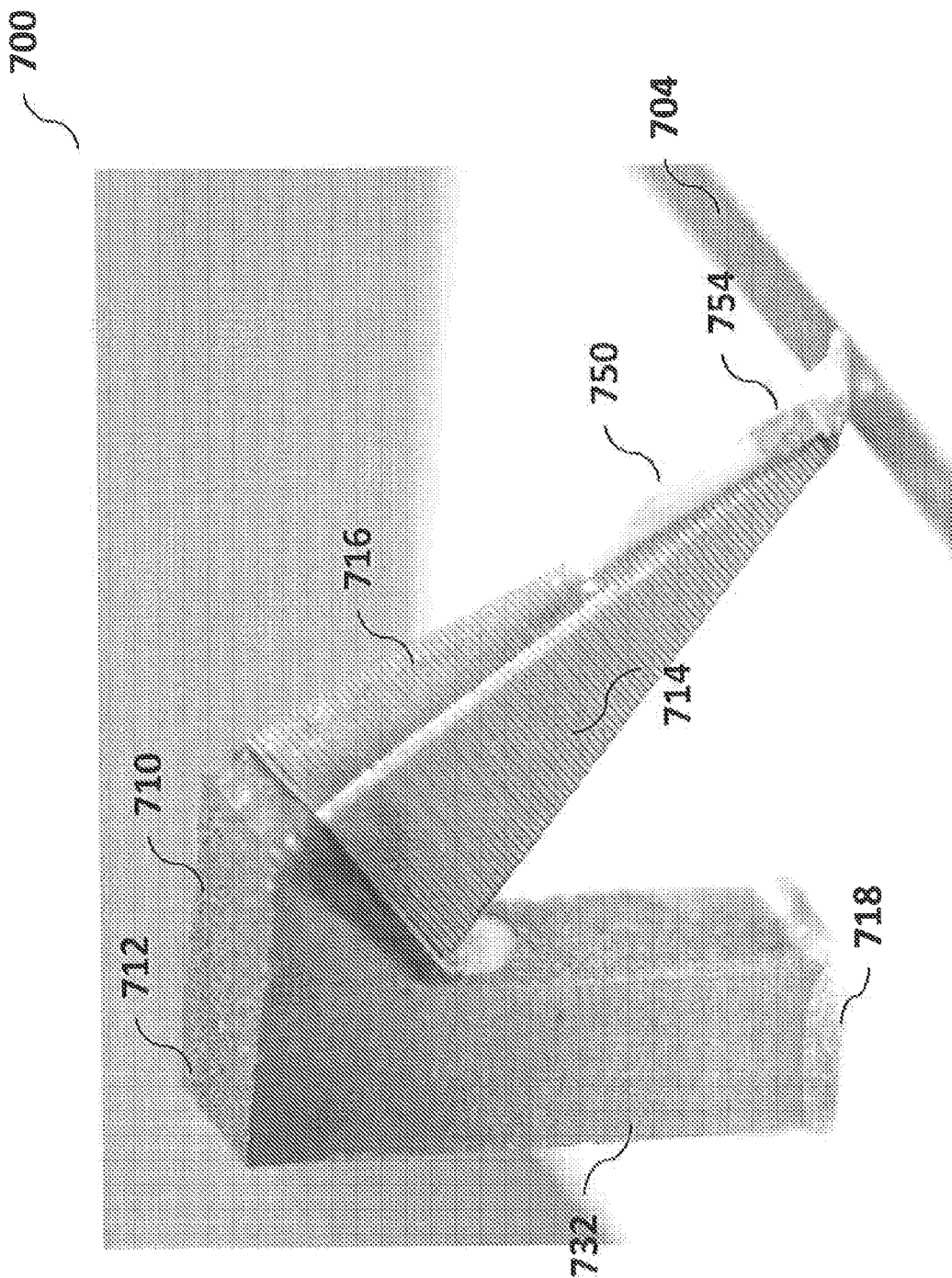


FIG. 7a.



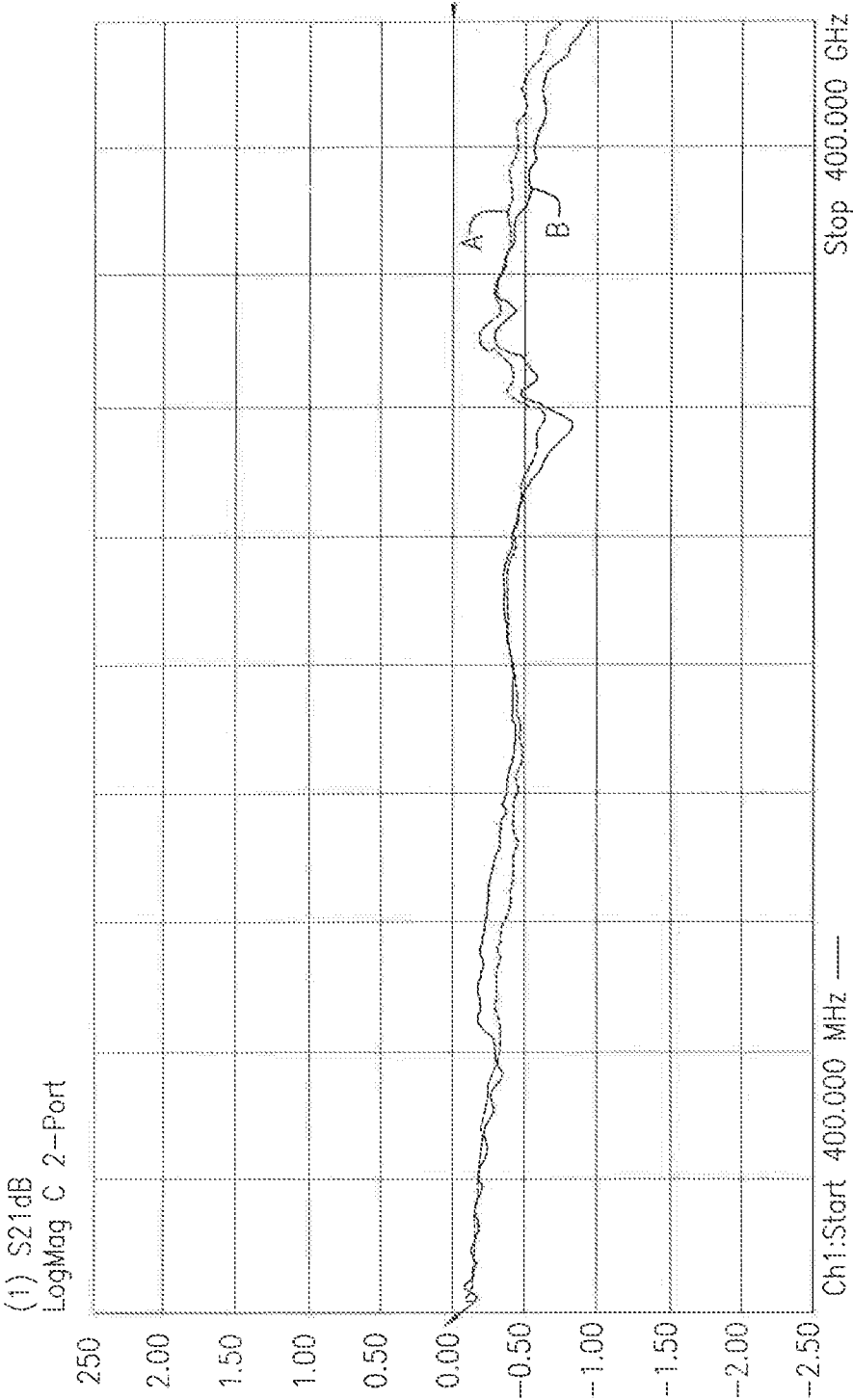


FIG. 8a

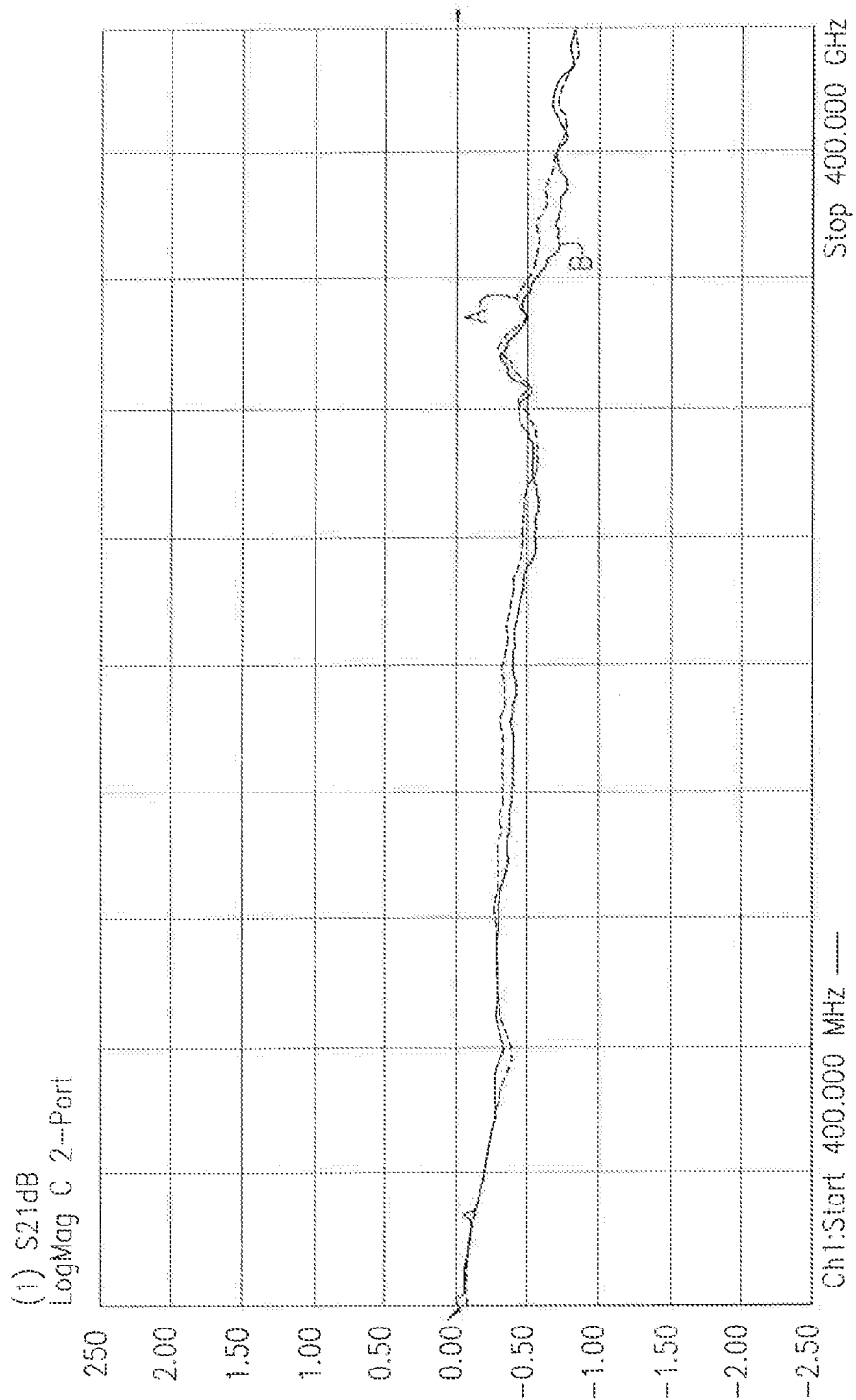
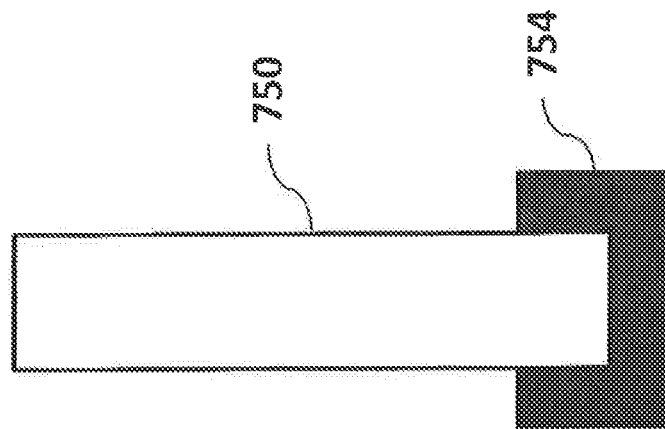


FIG. 8b

FIG. 9.



1

ULTRA-WIDEBAND ASSEMBLY SYSTEM AND METHOD

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application claims priority to and is a divisional of U.S. patent application Ser. No. 13/100,521, filed Mar. 4, 2011, entitled "Ultra-Wideband Assembly System", which is a continuation-in-part of U.S. patent application Ser. No. 12/080,646 to Mruz, filed on Apr. 4, 2008, and entitled "Ultra-Wideband Assembly System and Method," the disclosures of which are incorporated herein by reference in its entirety.

TECHNICAL FIELD

Some embodiments of the current subject matter generally relate to electrical circuits. Specifically, the current subject matter relates to ultra-wideband assembly systems and methods that provide a wide range of operational frequencies with low insertion loss. In some embodiments, the current subject matter relates to coil brackets for use in ultra-wideband assembly systems and methods.

BACKGROUND

With the development of multi-media technology, there is an increasing demand for constructing optical communication networks that are capable of providing transmissions at high speeds and accommodating large volumes of information. There is also a demand to provide such transmissions at lowered costs and over long distances. Various conventional systems that provide transmission high rates between 10 Gb/s to over 40 Gb/s have been developed or are currently under development.

To accommodate such high speeds of transmission, electronic circuits having bias-tee (also referred to as "bias-T") packages disposed on transmitter-receivers have been developed. A conventional bias-tee circuit is in actuality a form of a multiplexer having three ports arranged in the shape of a "T" and having frequencies ranging from below 30 KHz to at least 40 GHz pass horizontally through the T, and combine with much lower frequencies including DC from the bottom path used to bias and/or modulate transistors, diodes, and passive circuits. The circuit is a simple composition of one capacitor and one coil with some attention paid to details.

In the conventional systems, the construction of a horizontal bar of the T is based on one or more of the many forms of transmission line having low-loss, non-conducting material, including gas, act as a dielectric. At one point, a small slice is cut out from the transmission line conductor. Thus, a capacitor is formed and low frequencies are blocked. This kind of capacitor has an advantage that it is nearly invisible to higher frequencies. To pass frequencies of typically several megahertz and lower, the capacitance has to be increased. An ultra-wideband capacitor, such as type 545L capacitor manufactured by American Technical Ceramics Corporation, and disclosed in the co-owned U.S. Pat. No. 7,248,458 to Mruz, the disclosure of which is incorporated herein by reference in its entirety, can be configured to accomplish this task without adding significant perturbations to the insertion loss and return loss characteristics of the original straight-through line.

A small coil made of fine wire with an air core, a dielectric core, ferrite core, or a powdered iron core connects the inner conductor of one of the sides of the capacitor with the port in

2

the outer conductor leading down the T. Frequencies above of approximately 16 KHz hit the coil at the small end. Because of increasing diameters of the coil as the windings progress along the tapered length of the core, its resonances are distributed across the entire frequency range of the T causing its inductive reactance characteristic to vary uniformly with frequency. This results in a virtually resonance-free increase in the inductiveness of the coil, which, in-turn, causes a linear reduction in an RF leakage from the transmission line, as the frequency increases. Because of size constraints, this type of single layer, tapered coil cannot be made with enough inductance to sufficiently prevent RF leakage that occurs at very low frequencies. Thus, conventional systems implement a second coil, having considerably more inductance, to be placed in-series with the first tapered coil starting at the large end of the first tapered coil.

Any resonances that may result from the larger coil and interactions between these two tandem coils are dampened by two resistors placed across the larger coil and in-series with both coils, respectively.

The conventional bias-tee packages are commonly used for biasing of photodiodes (vacuum and solid state), Microchannel plate detectors, transistors, and triodes. This stops high frequency energy from leaking onto a common power supply rail and stops noise from the power supply from leaking onto the signal line.

The conventional systems employing the bias-tee packages suffer high and erratic insertion loss (i.e., a decrease in transmitted signal power) when operated over a wide range of operational frequencies. Thus, there is a need for a system that can operate in a wide range of frequencies and with low and well-behaved insertion loss.

SUMMARY

In some embodiments, the current subject matter relates to an ultra-wideband assembly in an electrical circuit having a circuit board with a conductive micro-strip line is provided. The assembly includes a non-conductive tapered core having an outer surface, a distal end, and a proximate end. The distal end is being larger than proximate end. The assembly includes a conductive wire having a proximate end and a distal end and being wound about at least a portion of the non-conductive tapered core. The proximate end of the conductive wire extends away from the proximate end of the non-conductive tapered core and is being conductively coupled to the micro-strip line of the circuit board. The distal end of the conductive wire extends away from the distal end of the non-conductive tapered core. The conductive wire contacts at least a portion of the outer surface of the non-conductive tapered core. The assembly includes a supporting bracket coupled to the non-conductive tapered core. The bracket includes a base portion and a core attachment portion. The base portion is being conductively coupled to the circuit board. The core attachment portion is being coupled to the distal end of the non-conductive tapered core and is further being conductively coupled to the distal end of the conductive wire. While being coupled to the non-conductive tapered core, the supporting bracket is configured to dispose the non-conductive tapered core at a predetermined angle to the circuit board.

In some embodiments, the following optional features can also be included. The predetermined angle can be in a range of greater than or equal to 10 degrees and up to substantially 90 degrees with respect to the circuit board. The assembly can also include a dielectric layer disposed on top of at least a portion of the conductive wire being wound on the non-

conductive tapered core, the dielectric layer being disposed substantially near the proximate end of the non-conductive tapered core. The assembly can include a metal pad coupled to the dielectric layer at the proximate end of the non-conductive tapered core. The dielectric layer can be configured to extend away from the outer surface of the non-conductive tapered core. The dielectric layer can have a thickness in range between approximately 0.004 inches to approximately 0.035 inches. The dielectric layer can be manufactured from low loss dielectric material having a low dielectric constant. The dielectric material can be a hydrocarbon ceramic loaded glass. The metal pad can have a thickness in the range of approximately 0.0005 inches to approximately 0.003 inches. The metal pad can include a copper layer, whereby the copper layer is configured to be initially electroless-deposited on the dielectric layer and then electroplated onto the dielectric layer and then the copper layer is configured to be plated with a metal selected from a group consisting of tin, lead/tin combination, silver, and gold. The metal pad can be configured to contact the proximate end of the conductive wire to generate a robust contact with a micro-strip line of the circuit board. The supporting bracket and the distal end of the conductive wire can provide a robust contact with the circuit board. The non-conductive tapered core can have a tetrahedron shape. The non-conductive tapered core can have a triangular pyramid shape. The non-conductive tapered core can also have a multi-dimensional polygonal shape. The non-conductive tapered core can be composed of powdered iron. The assembly can be configured to reduce insertion loss in a frequency range from below 10 KHz to over 100 GHz. The dielectric material can be manufactured from a material selected from a group consisting of: a hydrocarbon ceramic loaded glass, ceramic, ceramic reinforced glass or PTFE-based materials, PTFE materials reinforced with glass fibers, hydrocarbon ceramic composites, and rigid plastic.

In some embodiments, the current subject matter relates to a method of manufacturing an ultra-wideband assembly for placement in an electrical circuit having a circuit board with a conductive micro-strip line. The method includes providing a non-conductive tapered core an outer surface, a distal end, and a proximate end. The distal end being larger than proximate end. The method includes providing a conductive wire having a proximate end and a distal end and winding the conductive wire about at least a portion of the non-conductive tapered core. The proximate end of the conductive wire extends away from the proximate end of the non-conductive tapered core and is being conductively coupled to the micro-strip line of the circuit board. The distal end of the conductive wire extends away from the distal end of the non-conductive tapered core. The conductive wire contacts at least a portion of the outer surface of the non-conductive tapered core. The method also includes providing a supporting bracket for coupling to the non-conductive tapered core. The supporting bracket having a base portion and a core attachment portion. The base portion is being conductively coupled to the circuit board. The core attachment portion is being coupled to the distal end of the non-conductive tapered core and is further being conductively coupled to the distal end of the conductive wire. While being coupled to the non-conductive tapered core, the supporting bracket is configured to dispose the non-conductive tapered core at a predetermined angle to the circuit board.

Further features and advantages of the invention, as well as structure and operation of various embodiments of the invention, are disclosed in detail below with references to the accompanying drawings.

BRIEF DESCRIPTION OF THE FIGURES

The current subject matter is described with reference to the accompanying drawings. In the drawings, like reference numbers indicate identical or functionally similar elements. Additionally, the left-most digit(s) of a reference number identifies the drawing in which the reference number first appears.

FIGS. 1*a-i* illustrate exemplary non-conductive tapered cores, according to some embodiments of the current subject matter.

FIG. 2*a-b* illustrates exemplary non-conductive tapered core assemblies having a metal bracket, according to some embodiments of the current subject matter.

FIG. 3*a* illustrates exemplary non-conductive tapered core having a dielectric layer and a metal pad, according to some embodiments of the current subject matter.

FIGS. 3*b-c* illustrate another exemplary non-conductive tapered core assemblies having a metal bracket, according to some embodiments of the current subject matter.

FIG. 4*a-b* illustrate exemplary capacitor(s) mounting, according to some embodiments of the current subject matter.

FIGS. 5*a-f* illustrate exemplary bias-tee assemblies, according to some embodiments of the current subject matter.

FIG. 5*g* illustrates another exemplary non-conductive tapered core assembly having a metal bracket, according to some embodiments of the current subject matter.

FIG. 6 illustrates two plots depicting insertion loss and return loss using bias-tee assemblies of the current subject matter.

FIGS. 7*a-b* illustrates exemplary coil brackets, according to some embodiments of the current subject matter.

FIGS. 8*a-b* illustrate plots comparing performance of the stand alone coils and coils having a coil bracket.

FIG. 9 illustrates an exemplary "wrapping-around" of a metal pad about a dielectric layer of the non-conductive tapered core assembly, according to some embodiments of the current subject matter.

DETAILED DESCRIPTION

The current subject matter generally relates to electrical circuits and more specifically, the current subject matter relates to ultra-wideband assembly systems and methods that improve operational frequencies of electrical circuits. In some embodiments, the current subject matter relates to a pick-and-place coil bracket. In some embodiments, the current subject matter relates to a pick-and-place coil bracket having a dielectric tip.

In some embodiments, the current subject matter relates to a non-conductive tapered core assembly for mounting the core in an electrical circuit to improve operational frequency range. FIGS. 1*a-h* illustrate an exemplary non-conductive tapered core **100**, according to some embodiments of the current subject matter. The core **100** has a shape of a pyramidelepipiped (i.e., a pyramid having a parallelogram base). In some embodiments, the core **100** can be a square, a rectangular, a triangular, a polygonal, or any other type pyramidal or other multi-dimensional structure. In some embodiments, the core **100** can be manufactured from powdered iron particles.

FIG. 1*a* illustrates an exemplary powdered core **100**, according to some embodiments of the current subject matter. As illustrated, the core **100** is configured in a form of a pyramidelepipiped. As can be understood by one skilled in the art, the form of the core **100** can be varied and the core can have a tetrahedron pyramid shape (as shown in FIG. 1*a*), a triangular pyramid shape (as shown in FIG. 1*g*), or any other

multi-dimensional polygonal shape (as shown in FIG. 1*b*). One of the advantages of the pyramidelepipiped core **100** shown in FIG. 1*a*, is that it is easier to form and wind than other shapes of the core. Further, the core having a square cross-section provides a typical inductance of 12 μ H when #47 copper wire that is coated with single-build FORMAR® material or is fully wound on a 0.250 inch long taper with a 0.064 inch square distal end and a sharp pointed proximate end. As can be understood by one skilled in the art, other inductances along with different types of wiring and sizing can be used. The above example is provided for exemplary non-limiting purpose. The triangular and flat shaped cores, as shown in FIGS. 1*g* and 1*h*, may be physically suited in specific applications, for example, accommodation of drop-on assemblies. The cores shown in FIGS. 1*a-f* are configured to include a tapering angle α , which can be defined as twice the angle formed by one of the facets of the pyramidelepipiped triangular cores with a plane that intersects the vertex of pyramidelepipiped and is perpendicular to the base of the pyramidelepipiped (as shown in FIG. 1*i*, illustrating a two-dimensional view of the tapered core **100**). In some embodiments, the tapering angle α can be in a range from less than 10 degrees to greater than 25 degrees. In alternate embodiments, the tapering angle α can be in a range of 17-19 degrees. In yet other embodiments, the tapering angle α can be 18 degrees. In some embodiments, the tapering angle can be uniform throughout the pyramidelepipiped. In alternate embodiments, the tapering angle can vary from facet to facet of the pyramidelepipiped. Also, the tapering angle of the core can vary according to the angle of mounting of the core assembly with respect to the circuit board (as illustrated in FIGS. 5*a-c*). Depending on the applications, the tapering angle can be a function of the angle of mounting of the core assembly on the circuit. In some embodiments, the tapering angle can be a function of the angle of mounting of the core assembly on the circuit (and vice versa).

The core **100** has an outer surface **102**, a distal end **104**, and a proximate end **106**. The distal end **104** is configured to be larger than the proximate end **106**. The proximate end **106** is configured to be mounted adjacent to a transmission line on a circuit board, as will be discussed below.

A surface area of vertex of the pyramidelepipiped shown in FIG. 1*a* can be configured to be a sharp point having a surface area of substantially zero. This allows forming a sharp point with the wire that is being wound up to the vertex of the pyramidelepipiped. In some alternate embodiments, the surface area of the vertex point can be configured to be in the range between 0 to approximately 0.000025 square inches. A surface area of each of the side facets of the pyramidelepipiped shown in FIG. 1*a* is configured to be on the order of between 0.007951 square inches for the blunt tip and 0.00800 square inches for the sharp tip in this specific example. The surface area of the distal end (i.e., the parallelogram) is configured to be on the order of approximately 0.0041 square inches. As can be understood by one skilled in the art, the above values are provided for exemplary, non-limiting purposes, and other surface areas are possible.

FIGS. 1*b* and 1*c* illustrate exemplary embodiments of the powdered core **114** having a dielectric **111** disposed partially on the outer surface of the core, according to some embodiments. FIG. 1*b* illustrates that the dielectric **111** is disposed adjacent the proximate end of the powdered core **114**. The dielectric material **111** is configured to lower the coil's insertion loss at higher frequencies (i.e., frequencies typically above 300 MHz). Additionally, the core material is separated from the RF end of the coil, which causes the lowering of resulting insertion loss when placed near a transmission line.

In some embodiments, the dielectric material **111** can be configured to assist in formation of the soft iron into the shape of the powdered core **114**, and thus, allows for formation of a sharp vertex of the pyramidelepipiped. Additionally, the dielectric material **111** can also be configured to serve as a protective measure, thereby preventing breakage of the powdered iron core during winding operations. In some embodiments, the dielectric material is Rogers TMM6 material, available from Rogers Corporation, Rogers, Conn., USA. Other dielectric materials that can be used to replace portions of the powdered iron core include dielectric materials having a dielectric constant (which is defined as a measure of the extent, under given conditions, to which the material concentrates electrostatic lines of flux) of eight or below.

FIG. 1*b* illustrates that the dielectric **111** is disposed throughout the proximate region of the powdered core **114**. In some embodiments, the dielectric **111** can be disposed on the core **114** in a tapering fashion and configured to replace a portion of the core **114**, so that the core **114** appears smooth and without any protrusions, as illustrated in FIG. 1*c*, which shows four orthogonal views of the same core. Such tapering disposition of dielectric also allows for a gradual change in the length of the turns of the wiring. Such gradual change in length of the turns is configured to allow better distribution of resonances of the coil winding. This can be advantageous for some application as compared to the core assembly shown in FIG. 1*b*, where dielectric is applied only to the tip of the core assembly and coil windings experience a sharp change along its winding length, which may cause small resonance effect that will generate insubstantial variations in the swept insertion loss response. These variations are not noticeable where the tapered dielectric, shown in FIG. 1*c*, is employed. However, the inductance of the coil assemblies with tapered dielectric, shown in FIG. 1*c*, is less than the coil assemblies with a dielectric being disposed at the tip of the core, as shown in FIG. 1*b*. As can be understood by one skilled in the art, the dielectric material can be disposed on the core according to any desired configuration of the system using the coil assemblies, as shown in FIGS. 1*b-c*.

FIGS. 1*d-1f* illustrate exemplary embodiments of the powdered core **124** having a conductive wire **126** wound (forming a winding **125**) on the outer surface **128** of the core **124**, according to some embodiments of the current subject matter. The conductive wire **126** includes a proximate end **132** and a distal end **134**. The proximate end **132** is configured to be disposed substantially adjacent the proximate end **138** of the core **124**. The distal end **134** is configured to be disposed substantially adjacent the distal end **140** of the core **124**. The proximate end **132** is configured to connect the conductive wire **126** to a transmission line of the electrical circuit (not shown in FIG. 1*d*). The proximate end **132** of the wire **126** is further configured to extend away from the proximate end **138** of the core **124**. The distal end **134** can be configured to be coupled to an inductor (not shown in FIG. 1*d*, but is shown in FIGS. 5*a-f* below). The distal end **134** of the wire **126** is configured to extend away from the distal end **140** of the core **124**.

The proximate end **132** of the conductive wire **126** is configured to extend in the range of 0 inches to approximately 0.010 inches (in some embodiments, the proximate end **132** can extend in the range of 0.001 inches to less than 0.006 inches) away from the proximate end **138** of the core **124**. In some embodiments, the length of proximate end **132** of the conductive wire **126** extending from the proximate end **138** of the core **124** is approximately 0.006 inches.

The conductive wire **126** is configured to have a diameter in the range of about 0.001 inches to about 0.013 inches. In some

embodiments, the range of diameters of the wire can be from 0.005 inches to about 0.009 inches. In some embodiments, the diameter is equal to about 0.0007 inches. In some applications and embodiments, the diameter of the wire can extend beyond the 0.001 to 0.013 inches range. These applications relate to both the required inductance valve and the current carrying capacity of the coil which interdependently relate to both wire diameter and wire length (as length relates to the number of turns). Such applications include amplifier front-end and driver stage decoupling networks, varactor diode bias voltage RF isolation inductors, and PIN switch DC driver networks. As can be understood by one skilled in the art, other diameters of the wire are possible. The wire 126 is configured to be wound around the entire conductive core 124. In some embodiments, the wire 126 is configured to be wound around a portion of the conductive core 124. Such partial winding can be useful in applications such as those shown in and discussed in connection with FIG. 5a. In these embodiments, the distal end of the core assembly is sometimes machined off at an odd angle to make it compatible (mechanically or otherwise) with another coil assembly to which the first assembly is being coupled.

As illustrated in FIGS. 1d-1f, the wire 126 is wound around the core 124 so that there is substantially no spacing between the turns of the wire 126, i.e., the wire 126 is being tightly wound around the core 124. In some applications and/or as desired, the wire 126 can be wound around the core 124 with some predetermined spacing. This spacing can either be constant along the length of the coil or it can vary along the length of the coil.

In some embodiments where the above tapered coils are used, the ultra-wideband assembly formed by the core and the windings discussed above, when connected in a circuit are configured to maintain signal levels (or minimize insertion loss, which is the decrease in transmitted signal power resulting from the insertion of a device in a transmission line or optical fiber) in a frequency range of below 70 MHz to at least 40 GHz. In some embodiments where smaller tapered coils are employed, the lower frequency attenuation limits can be moved substantially higher than the 70 MHz and remain extended to at least 40 GHz. In some embodiments, the current subject matter's assemblies are configured to maintain signal levels (or minimize insertion loss) to below 1.0 decibel ("dB") in a frequency range of at least 16 KHz to 40 GHz. Further, in some embodiments, the current subject matter's assemblies can be configured to maintain signal levels in a range from below 100 KHz to over 100 GHz range.

There are various ways to manufacture the tapered core 124. In some embodiments, the tapered core can be pressed into a mold by conventional press equipment that is configured to press iron cores into a desired shape (or one shown in FIGS. 1a-h). One of the issues involved with using a mechanical press to manufacture tapered core is the fragility of the tapered core. Because of this characteristic, it is difficult to form a sharp point of the core (as shown in FIGS. 1a-1f), i.e., it typically breaks off.

In some embodiments, the material, i.e., iron powder, can be mixed with epoxy into a thick colloidal paste and then poured into a mold that has been sprayed with a release agent. The release agent is a substance used in molding and casting that aids in the separation of a mold from the material being molded and reduces imperfections in the molded surface. In this case, the examples of a release agent that can be used are typical non-contaminating release polymers manufactured by Frekote and others. Wax and silicon agents can also be employed. As can be understood by one skilled in the art, other types of release agents can be used. One of the issues

involved in this method of manufacturing the powdered core is that the epoxy that is suspended along with the iron particles makes the core somewhat ineffective as compared to the core without the epoxy. Thus, the resulting inductance of the core with the epoxy is only typically about 70% of what it could be without the epoxy.

Another way to manufacture the powdered core is to take a pressed rod (or any other configuration) and sand (or abrade) it into the configuration shown in FIGS. 1a-f. The pressed rod can be changed into the configuration shown in FIGS. 1a-f using any other suitable fashion or method. Then, in some embodiments, the sanded core can be coated with a thin varnish to strengthen it. Subsequent to the coating step, wire can be wound around the core starting at the proximal (or pointed end). In some embodiments, the winding can start within three turns of the pointed end.

In some embodiments, the inductance value of the tapered coil assemblies illustrated in FIGS. 1a-h can range from 2 microhenries ("μH") to over 20 μH. In alternate embodiments, the inductance value can range from 5-12 μH. Yet in other alternate embodiments, the inductance value of the assembly can be 10 μH.

As can be understood by one skilled in the art, the length of the core and the distal end cross-section dimensions can vary based upon, for example, the number of turns of the wire that are desired, as well as any other parameters of the assembly. In some embodiments, the area of the proximate tip does not vary.

FIG. 2a illustrates an exemplary ultra-wideband assembly 200 that includes the conductive tapered core 202 having a metal bracket 220 configured to be coupled to the core 202 to the circuit board 254, according to some embodiments of the current subject matter. The core 202 includes a conductive wire winding 204 configured to be wound around the core 202 in a fashion similar to the winding around core 101 illustrated in FIGS. 1a-h. The conductive tapered core 202 includes an outer surface 206, a distal end 208, and a proximate end 210. The distal end 208 is configured to have a larger surface area than the proximate end 210. The proximate end 210 is configured to be disposed substantially adjacent a micro-strip transmission line 252 of the circuit board 254. The conductive wire 204 includes a proximate end 212 and a distal end 214. The proximate end 212 is configured to be disposed substantially adjacent the proximate end 210 of the core 202. The distal end 214 is configured to be disposed substantially adjacent the distal end 208 of the core 202. The proximate end 212 of the wire 204 is configured to be connected to the transmission line 252 of the circuit board 254. The distal end 214 of the wire 204 is configured to be coupled to a supporting bracket 220.

One end or a core attachment portion 224 of the bracket 220 is configured to be coupled to the distal end 208 of the core 202, as illustrated in FIG. 2a. Another end or a base portion 226 of the bracket 220 is configured to be coupled to the circuit board 254. The base portion 226 is also configured to be conductively coupled to the circuit board 254.

The bracket 220 is configured to position the core 202 having the winding 204 at a particular angle β with respect to the circuit board 254. In some embodiments, the angle between the central axis of the tapered core 202 and the horizontal top surface of the micro-strip board in a range of greater than 25 degrees to 90 degrees (i.e., substantially vertical mounting of the core 202). In some embodiments, range of angles is in the range of 40 degrees to 70 degrees. In some embodiments, the angle β is 63 degrees to the micro-strip line, as illustrated in FIG. 2b.

FIGS. 3*a-c* illustrate an exemplary ultra-wideband assembly 300 that includes the conductive tapered core 302 having a metal bracket 320 configured to couple the core 302 to the circuit board, according to some embodiments of the current subject matter.

The core 302 includes a conductive wire winding 304 configured to be wound around the core 302 in a fashion similar to the winding around core 101 illustrated in FIGS. 1*a-h*. The conductive tapered core 302 includes an outer surface 306, a distal end 308, and a proximate end 310. The distal end 308 is configured to have a larger surface area than the proximate end 310. The proximate end 310 is configured to be disposed substantially adjacent a micro-strip transmission line of a circuit board (not shown in FIGS. 3*a-c*). The conductive wire 304 includes a proximate end 312 and a distal end 314. The proximate end 312 is configured to be disposed substantially adjacent the proximate end 310 of the core 302. The distal end 314 is configured to be disposed substantially adjacent the distal end 308 of the core 302. The proximate end 312 of the wire 304 is configured to be connected to the transmission line of the circuit board.

In some embodiments, the ultra-wideband assembly 300 includes a dielectric layer 334 that is configured to be disposed substantially near the proximate end 310 of the core 302. In some embodiments, the dielectric layer 334 is configured to be disposed on top of at least a portion of the conductive wire 304. The thickness of the dielectric layer 334 can be in the range from 0.004 inches to about 0.035 inches. The thickness of the dielectric layer 334 can be on the order of approximately 0.010 inches. In some embodiments, the material of the dielectric layer can be Rogers RO4350, manufactured by Rogers Corporation, Connecticut, USA, which is a hydrocarbon ceramic loaded glass. This material is characterized by its strength, mechanical rigidity and stability over a wide range of temperatures. Other similar low loss, low dielectric constant materials with a thicknesses of 0.010 inches or less can be used if so desired. In some implementations, the width of the dielectric layer 334 can be uniform throughout, i.e., it can have the same width from its one end that is proximate to the transmission line and to its other end that is distal to the transmission line. In some embodiments, the width of the dielectric layer 334 can vary throughout, e.g., it can be narrower at its end that is proximate to the transmission line and it can be wider at its end that is distal to the transmission line. Alternatively, its width can be non-uniform with some portions of the layer 334 wider than others.

In alternate embodiments, the thickness of the dielectric layer can vary throughout the dielectric layer 334. Further, in some embodiments, the dielectric layer can be disposed on one side of the tapered core, while leaving the other side free of the dielectric layer. In some embodiments where the dielectric layer is disposed on the top side of the wound core, the connection between the tip of the fine wire wound around the core and the micro-strip line (or any other type of transmission line), allows the tip to be closer to the micro-strip line, thereby reducing resonant responses. In the embodiments where the dielectric is disposed on the bottom side of the core, i.e., closer to the transmission line (which makes the tip of the wire disposed further away from the transmission line), the resonant responses may be enhanced.

In some embodiments, the dielectric layer includes a metal pad 338. The metal pad 338 is configured to be disposed on at least a portion of the dielectric layer 334 and substantially adjacent to the proximate end of the core 304. The metal pad 338 can be configured to provide a robust contact to the proximate end 312 of the wire 304. In some embodiments, the metal pad 338 has a thickness in the range of approximately

0.0005 inches to approximately 0.003 inches. In some implementations, the thickness can be approximately 0.0007 inches (i.e., the thickness of a half-ounce copper cladding). The surface area of metal pad 338 can be configured to be on the order of approximately 0.003 square inches (i.e., approximately 0.025 inches×0.012 inches). In some embodiments, the metal pad is configured to be manufactured from copper that is initially electrolessly deposited on the dielectric. Electroless plating is an auto-catalytic reaction used to deposit a coating of metal on a substrate. Unlike electroplating, it is not necessary to pass an electric current through the solution to form a deposit. Electroless plating has several advantages versus electroplating. Free from flux-density and power supply issues, it provides an even deposit regardless of the work piece geometry, and with the proper pre-plate catalyst, can deposit on non-conductive surfaces. Subsequent to the electroless plating, the tip of the dielectric material plated with copper is electroplated with either tin, a combination lead and tin, silver, gold, or any other suitable metal.

As illustrated in FIGS. 3*a-c*, the dielectric layer 334 along with the metal pad 338 are configured to protrude away from the proximate end 312 of the conductive core 304. The metal pad is configured to contact the transmission line of the circuit (not shown in FIGS. 3*a-c*).

In some embodiments, the dielectric layer 334 is manufactured from a pure ceramic, ceramic reinforced glass, or polytetrafluoroethylene or polytetrafluoroethylene ("PTFE") based materials, PTFE materials reinforced with glass fibers, hydrocarbon ceramic composites, various rigid plastics, or any other suitable materials. The metal pad 338 is manufactured from copper, nickel, silver, gold, palladium, or any other suitable materials.

In some embodiments, the distal end 314 of the wire 304 is configured to be coupled to a supporting bracket 320. One end or a core attachment portion 324 of the bracket 320 is configured to be coupled to the distal end 308 of the core 302, as illustrated in FIGS. 3*a-c*. Another end or a base portion 326 of the bracket 320 is configured to be coupled to the circuit board. The base portion 326 is also configured to be conductively coupled to the circuit board 354. The bracket 320 is configured to position the core 302 having the winding 304 at a particular angle with respect to the circuit board (not shown in FIGS. 3*a-c*).

FIG. 4*a* illustrates an exemplary capacitance assembly system 400 for mounting a capacitor to a dielectric board to minimize assembly's perturbation of an electric field of a transmission line after mounting of the capacitor, according to some embodiments of the current subject matter. FIG. 4*a* illustrates a capacitor 402 mounted to a dielectric board 404. The capacitor 402 can be an ultra-broadband or any other capacitor. The capacitor 402 is configured to be mounted to the dielectric board 404 using a low loss, high temperature epoxy. In some embodiments, when the capacitor 402 is mounted to the dielectric board 404, an air space 406 is created between the capacitor 402 and the dielectric 404. When dielectric material is brought into close proximity with either a transmission line or an energy-carrying component, such as a capacitor, the dielectric material attracts energy into itself and changes the electrical characteristics of the item that it is drawing energy (i.e., electric field) from. This undesirable situation is minimized by removing as much of this dielectric as practical from the sensitive regions of these structures.

In some embodiments, the capacitor is configured to be directly attached to a transmission line of the circuit (not shown in FIG. 4*a*). In other embodiments, the capacitor can include ribbon leads 445 (*a*, *b*), as illustrated in FIG. 4*b*, that can be used to connect the capacitor to the transmission line of

11

the circuit. The capacitor assembly **400** is configured to minimize perturbation of an electric field of the circuit's transmission line subsequent to mounting of the capacitor **402**.

FIGS. **5a-f** illustrate an exemplary embodiment of an ultra-wideband assembly **500** that includes a surface mountable ultra-broadband bias-tee, according to some embodiments of the current subject matter. The assembly includes a tapered core **502**, an inductor **560**, an ultra-wideband capacitor **562**, a bypass capacitor **564**, and resistors **582**, **584**.

The core **502** includes a conductive wire winding **504** configured to be wound around the core **502** in a fashion similar to the winding around core **101** illustrated in FIGS. **1a-h**. The conductive tapered core **502** includes an outer surface **506**, a distal end **508**, and a proximate end **510**. The distal end **508** is configured to have a larger surface area than the proximate end **510**. The proximate end **510** is configured to be disposed substantially adjacent a micro-strip transmission line **552** of the circuit board **554**. The conductive wire **504** includes a proximate end **512** and a distal end **514**. The proximate end **512** is configured to be disposed substantially adjacent the proximate end **510** of the core **502**. The distal end **514** is configured to be disposed substantially adjacent the distal end **508** of the core **502**. The proximate end **512** of the wire **504** is configured to be connected to the transmission line **552** of the circuit board **554**.

The distal end **508** of the core **502** is configured to be coupled to a low frequency inductor **560**. The low frequency inductor **560** is configured to be mounted on dielectric substrate **570**, which is in turn coupled to the circuit board **554**, as illustrated in FIGS. **5a-f**. In some embodiments, the inductor **560** has a value of 220 μ H and is capable of handling 300 mA. As can be understood by one skilled in the art, the inductor **560** can have a different inductance values and can be capable of handling currents having different values. The above referenced numbers are provided here for exemplary purposes only and are not intended to limit the scope of the current subject matter.

The ultra-wideband assembly **500** further includes an ultra-wideband capacitor **562** mounted to the dielectric substrate **570**, as further illustrated in more detail in FIG. **5d**. The capacitor **562** can be configured to be mounted to the dielectric substrate **570** in a similar fashion as the capacitor shown in FIGS. **4a-b**. As such, the core **502** is configured to be coupled to the capacitor **562**, which is in turn, can be configured to be coupled to the transmission line **552** of the circuit board **554**. The capacitor **562** is coupled to the core near its proximate end **510** using the proximate end **512** of the conductive wire **504**. In some embodiments, the capacitor **562** can be coupled directly to the transmission line **552**. In alternate embodiments, the capacitor **562** can include conductive leads (shown in FIG. **4b**) that can be coupled the transmission line **552**.

The assembly **500** further includes a bypass capacitor **564** mounted on the dielectric substrate **570**. The capacitor **564** can be configured to be connected in parallel with the DC port of the bias T assembly to ground. In some embodiments, there can be more than one bypass capacitor **564** being connected to the bias T assembly **500**. The bypass capacitor(s) **564** can be configured to short any RF energy signals leaking through the ultra-wideband inductor **560** and the core assembly **502** to ground. This is accomplished by having the bypass capacitor(s) **564** being connected to the "cold side" of the ultra-wideband inductor **560** and to ground. As illustrated in FIGS. **5a** and **5f**, the bypass capacitor(s) **564** is disposed in the rear of the assembly **500**. As can be understood by one skilled in the art, the location of the bypass capacitor(s) **564** is not limited to being disposed in the rear of the bias-T assembly **500**. The

12

capacitors can be placed anywhere and then coupled to the assembly, as discussed above. In some embodiments, the capacitance of the bypass capacitor(s) **564** can range from 100 nano Farad ("nF") to over 220 nF. In some embodiments, the capacitance of the bypass capacitor(s) can extend beyond the above referenced range in various applications.

In some embodiments, the assembly **500** can further include a damping resistor **584** and an isolating resistor **582**, as illustrated in FIGS. **5a-b**. The resistor **584** is connected in-parallel with the ultra-wideband inductor **560** and is primarily used to dampen the resonant responses within that inductor **560**. The resistor **582** is an isolating resistor that dampens any potential interactions between networks that may be coupled to the bias-T assembly **500** and their respective electrical DC feed lines. In some embodiments, the resistance of the damping resistor **584** is configured to be in a range of 180 Ohms and higher. The resistance of the isolating resistor **582** is configured to be in a range of approximately 0 Ohms to approximately 100 Ohms.

The dielectric or base substrate **570** material can be manufactured from any insulating, rigid, low loss dielectric, either a uniform composite or reinforced woven structure having a loss tangent (which is a measure of loss-rate of power of an electrical mode, such as an oscillation, in a dissipative system) of 0.005 or less and a dielectric constant of 10 or less would be acceptable. As can be understood by one skilled in the art, any other suitable materials can be used for the dielectric substrate **570**.

In some embodiments, the ultra-wideband assembly **500** can be configured to attenuate signals in a frequency range of 16 KHz to about 40 GHz. In alternate embodiments, where smaller secondary coils are employed, the signals are attenuated in a frequency range of 300 KHz to about 40 GHz. In some embodiments, the upper and lower limits of the above frequency ranges can be specifically tailored to particular applications and can be configured to depend on the values of the inductor **560** and the coil assembly **502** as well as the ultra-wideband capacitor(s) **562**. In some embodiments, the range of signal frequencies being attenuated can be from below 10 KHz to well over 100 GHz.

In some embodiments, the assembly **500** further includes a protective cover **575** configured to protect isolating and damping resistors **582** and **584**, respectively. The cover **575** can be manufactured from any insulating, rigid, material that is either a uniform composite or reinforced woven structure. The assembly **500** can be further coupled to an external DC supply line **590**, as illustrated in more detail in FIGS. **5a**, **5c**, and **5f**. In some embodiments, Mylar tape or any other insulator **599** is configured to insulate bottom contact of the bias tee assembly from the micro-strip line ground contact. In some embodiments, the RF ground contact of the assembly is made with three bypass caps **588**. As illustrated in FIG. **5b**, the resistor **582** can be connected in series with a bias supply line **577**.

FIG. **5g** illustrates an alternate embodiment of the bias-T assembly **540**. The assembly **540** includes a supporting metal bracket **542**, a coil assembly **544**, and a capacitor assembly **546**. The assembly **540** is connected to the micro-strip circuit line **547**. The bracket **542** is similar to the brackets **220** and **320** discussed in connection with FIGS. **2a** and **3a-c** and can be configured to be coupled to the circuit board (not shown in FIG. **5c**). The coil assembly **544** is similar to the coil assemblies discussed in connection with FIGS. **1a-3c** and **5a-b**. The capacitor assembly **546** is also discussed in connection with FIG. **4a**. In some embodiments, the capacitor assembly **546** can be similar to the capacitor assembly **440** shown in FIG. **4b**. As illustrated in FIG. **4b**, the capacitor assembly **440**

13

includes capacitor **442** that is configured to be coupled to the transmission or micro-strip line (not shown in FIG. **4b**) via conductive ribbon leads **445a** and **445b**, respectively. An exemplary capacitor **442** can be an ultra-wideband capacitor, such as type 545L manufactured by American Technical Ceramics Corporation, and disclosed in a co-owned U.S. Pat. No. 7,248,458 to Mruz, the disclosure of which is incorporated herein by reference in its entirety. As illustrated in FIG. **4b**, a coating **443** is configured to protect a circumferential channel (not shown in FIG. **4b**) of the capacitor **442**. The capacitance value of the capacitor assembly **440** can be similar to the capacitance value stated above with regard to the assembly shown in FIG. **4a**. Referring back to FIG. **5g**, the capacitor **546** can include ribbon leads that connect the capacitor assembly to the transmission line **547**. Similarly to FIGS. **4a-b**, the capacitance value of the entire assembly can be substantially equal to the capacitance value of the assemblies shown in FIGS. **4a-b**. The assembly **540** further includes a low-loss dielectric element **549** (e.g., with a dielectric constant less than 10; as can be understood by one skilled in the art, materials with other dielectric constants can be used). In some embodiments, the thickness of the dielectric element **549** can be about 0.010 inches thick. The dielectric **549** is glued to the coil, and the capacitor is glued to its two legs **575a** and **575b**, as shown in FIG. **5g**. The wire from the coil **544** tip is then directly connected to one of the two capacitor terminals. This forms the bias tee of **540**. Because, there is no secondary coil, the low frequency end of this bias tee is about 2 MHz; the upper end is about 40 GHz. In some embodiments, when a secondary coil is included, the assembly **540** can cover the frequency range from below 16 KHz to above 40 GHz.

FIG. **6** illustrates two typical plots depicting both the insertion loss and return loss characteristics of the bias tee assemblies illustrated in FIGS. **5a-f**. As can be seen from the plots, no resonances were noted from 400 MHz to 40 GHz. Further, insertion loss and return loss remained below 0.8 dB and 15 dB, respectively. The device remains virtually resonance free to its lower 3 dB roll-off frequency which is typically below 100 KHz.

FIG. **7a** illustrates an exemplary ultra-wideband assembly **700** that includes the tapered core **716** coupled to a supporting bracket **710** configured to be coupled to a circuit board or any other substrate **702**, according to some embodiments of the current subject matter. The core **716** includes a conductive wire winding **714** configured to be wound around the core **716** in a fashion similar to the winding around core illustrated and discussed in connection with FIGS. **1a-5g**. The wire **714** can be wound around the core **716** in any desired number of turns. The tapered core **716** includes a distal end **724** and a proximate end **722**. The distal end **724** is configured to have a larger surface area than the proximate end **722**. The proximate end **722** is configured to be disposed substantially adjacent a micro-strip transmission line **704** of the circuit board **702** at a coupling point **720**. The conductive wire **714** includes a proximate end and a distal end (not shown in FIG. **7a**). The proximate end of the wire **714** is configured to be disposed substantially adjacent the proximate end **724** of the core **716**. The distal end of the wire **714** is configured to be disposed substantially adjacent the distal end **722** of the core **716**. The proximate end of the wire **714** is configured to be connected to the transmission line **704** of the circuit board **702** at the coupling point **720**. The distal end of the wire **714** is configured to be coupled and/or electrically coupled and/or coupled in any other fashion to the bracket **710**.

The bracket **710** is configured to include a horizontal or a core attachment portion **712** and a vertical or a base portion

14

732. The horizontal portion **712** is configured to include a flat top surface **715**, and flat side surfaces **717** (*a, b*), and a core end **736** having a slanted face. The vertical portion **732** is configured to include an end **734** that is configured to be coupled to the substrate or the circuit board **702**. The vertical portion **732** can be soldered (**718**) to the circuit board **702**. As can be understood by one having ordinary skill in the relevant art, the bracket **710** can be glued, welded, soldered, heat-sealed, molded into the circuit board, or attached to the circuit board in any other fashion. The horizontal portion **712** is configured to be coupled to the vertical portion **732** and include a core end **736** at which the horizontal portion **712** is configured to be mounted to the core **716**. The core end **736** of the horizontal portion **712** is configured to have a slanted face to allow for coupling of the distal end **724** of the core **716**. The core end **736** can be further configured to have an area that is substantially equal or greater than the area of the distal end **724** of the core **716**. In some embodiments, the area of the slanted face of the core end **736** can be less than the area of the distal end **724** of the core **716**. The horizontal portion **712** is configured to be disposed at a substantially right angle with respect to the vertical portion **732**. As can be understood by one having ordinary skill in the relevant art, the horizontal and vertical portions of the bracket **710** can be coupled to one another at any desired angle.

The vertical and horizontal portions **712, 732** are configured to be coupled to one another to allow positioning of the core **716** at a predetermined angle γ with respect to the circuit board **702**. In some embodiments, the angle γ between the central axis of the tapered core **716** and the horizontal top surface of the micro-strip board can be in a range of greater than 25 degrees to 90 degrees (i.e., substantially vertical mounting of the core **716**, whereby the face of the core end **736** of the bracket **710** can be configured to be substantially parallel to the surface of the circuit board **702**). In some embodiments, range of angles is in the range of 40 degrees to 70 degrees. In some embodiments, the angle γ is 63 degrees to the micro-strip line, as illustrated in FIG. **2a**. The angle γ can be configured to depend on an angle of the slanted face of the core end **736** of the bracket **710**. As such, decrease in the angle of the slanted face with respect to the top surface of the horizontal portion **712** implies increase in the angle γ and vice versa.

The vertical and horizontal portions of the bracket **710** can be formed from a single piece of material, or can be welded, glued, epoxied, soldered, or attached to one another in any desired way. The horizontal portion **712** is configured to be coupled to the core **716** via glue, welding, soldering, epoxy, or in any other desired fashion.

FIG. **7b** illustrates another exemplary ultra-wideband assembly **760** that includes the tapered core **716** coupled to the bracket **710** that is configured to couple the core **716** to the circuit board **702**, according to some embodiments of the current subject matter. Similarly to FIG. **7a**, the core **716** includes the conductive wire winding **714** configured to be wound around the core **716** in a fashion similar to the winding around core illustrated in FIGS. **1a-5g**. In some embodiments, the ultra-wideband assembly **760** includes a dielectric layer **750** that is configured to be disposed substantially near the proximate end **722** of the core **716**. In some embodiments, the dielectric layer **750** is configured to be disposed on top of at least a portion of the conductive wire **714**. The thickness of the dielectric layer **750** can be in the range from 0.004 inches to about 0.035 inches. The thickness of the dielectric layer **750** can be on the order of approximately 0.010 inches. In some embodiments, the material of the dielectric layer can be characterized by a low dissipation loss, predetermined

15

strength, mechanical rigidity and stability over a wide range of temperatures (e.g., Rogers RO4350, manufactured by Rogers Corporation, Connecticut, USA, which is a hydrocarbon ceramic loaded glass). As can be understood by one having ordinary skill in the relevant art, other similar low loss, low dielectric constant materials with thicknesses of 0.025 inches or less can be used if so desired. The dielectric layer can also be configured to have a uniform or varying width similar to the one discussed and shown in connection with FIGS. 3a-c above.

In some embodiments, the thickness of the dielectric layer can vary throughout the dielectric layer 750. The dielectric layer 750 can be disposed on at least one side of the core 716, while leaving at least one other side free of the dielectric layer. In some embodiments where the dielectric layer is disposed on the top side of the wound core, the connection between the tip of the fine wire wound around the core and the micro-strip line 704 (or any other type of transmission line), allows the tip to be closer to the micro-strip line 704, thereby reducing resonant responses. In the embodiments where the dielectric is disposed on the bottom side of the core, i.e., closer to the transmission line 704 (which makes the tip of the wire disposed further away from the transmission line), the resonant responses may be enhanced, as discussed above in connection with FIGS. 3a-c.

Similarly to the embodiments illustrated in FIGS. 3a-c, the dielectric layer 750 can include a metal pad 754. The metal pad 754 can be configured to be disposed on at least a portion of the dielectric layer 750 and substantially adjacent to the proximate end 722 of the core 716. The metal pad 754 can be configured to provide a robust contact to the proximate end of the wire 714. Similar to FIGS. 3a-c and corresponding discussion, the metal pad is configured to be manufactured from copper that can be initially electrolessly deposited on the dielectric. In some implementations, the metal pad can have a thickness in the range of approximately 0.0005 inches to approximately 0.003 inches. In some implementations, the metal pad 754 can be configured to “wrap-around” the dielectric layer 750, as illustrated in FIG. 9. The “wrap-around” can allow for better adhesion of the metal pad 754 to the dielectric layer 750. The “wrapping-around” of the metal pad 754 can be done around any surface of the dielectric layer 750 (e.g., two sides and a bottom surface; front and back surface and the bottom surface; or in any other fashion). The metal pad 754 can be coupled to the dielectric layer 750 in any other suitable fashion.

In some embodiments, the dielectric layer 750 can be manufactured from a pure ceramic, ceramic reinforced glass, or polytetrafluoroethylene or polytetrafluoroethylene (“PTFE”) based materials, PTFE materials reinforced with glass fibers, hydrocarbon ceramic composites, various rigid plastics, or any other suitable materials. The metal pad can be manufactured from copper, nickel, silver, gold, palladium, or any other suitable materials.

FIGS. 8a-b are exemplary plots illustrating performance comparison of the tapered cores, where plot A corresponds to the tapered core mounted on the bracket 710 and plot B corresponds to the tapered core without being mounted on the bracket 710. The performance comparison is executed over a frequency range of 400 MHz to 40 GHz. As can be seen from FIGS. 8a-b, both cores perform substantially identically. However, the conductive tapered core mounted on the bracket 710 can be advantageously used for easy and convenient mounting at any desired angle to the circuit board. Further, use of the bracket 710 allows for efficient manufacturing (e.g., cores coupled to the brackets can be placed on a “tape”

16

reel) and placement on the circuit board as well as coupling to the transmission line in a “pick-and-place” fashion using an appropriate equipment.

In some embodiments, the bracket 710 can be manufactured from brass, aluminum, or any other metal and/or a combination or an alloy of metals. In some embodiments, the bracket can be manufactured from a non-metallic material. In this embodiment, a contact can be provided for the distal end lead. In some embodiments, the bracket can be manufactured from a non-metallic substance but can be metalized. Other types of materials can be used to manufacture the bracket 710 that can include a flat top surface and can be surface mount technology (“SMT”) compatible.

In some embodiments, the current subject matter relates to an ultra-wideband assembly in an electrical circuit having a circuit board with a conductive micro-strip line and a method of manufacturing thereof. The assembly can include a non-conductive tapered core having an outer surface, a distal end, and a proximate end. The distal end can be larger than the proximate end. The assembly can also include a conductive wire having a proximate end and a distal end and being wound about at least a portion of the non-conductive tapered core. The proximate end of the conductive wire can extend away from the proximate end of the non-conductive tapered core and can be conductively coupled to the micro-strip line of the circuit board. The distal end of the conductive wire can extend away from the distal end of the non-conductive tapered core. The conductive wire can contact at least a portion of the outer surface of the non-conductive tapered core. The assembly can also include a supporting bracket coupled to the non-conductive tapered core and having a base portion and a core attachment portion. The base portion can be conductively coupled to the circuit board. The core attachment portion can be coupled to the distal end of the non-conductive tapered core and is further being conductively coupled to the distal end of the conductive wire. While being coupled to the non-conductive tapered core, the supporting bracket can be configured to dispose the non-conductive tapered core at a predetermined angle to the circuit board.

In some implementations, the current subject matter can include the following optional features. The predetermined angle can be in a range of greater than or equal to 10 degrees and up to substantially 90 degrees with respect to the circuit board. The assembly can include a dielectric layer disposed on top of at least a portion of the conductive wire being wound on the non-conductive tapered core, the dielectric layer being disposed substantially near the proximate end of the non-conductive tapered core. The assembly can also include a metal pad coupled to the dielectric layer at the proximate end of the non-conductive tapered core. The dielectric layer can be configured to extend away from the outer surface of the non-conductive tapered core. The dielectric layer can have a thickness in range between approximately 0.004 inches to approximately 0.035 inches. The dielectric layer can be manufactured from low loss dielectric material having a low dielectric constant. The dielectric material can be a hydrocarbon ceramic loaded glass. The metal pad can have a thickness in the range of approximately 0.0005 inches to approximately 0.003 inches. The metal pad can include a copper layer, whereby the copper layer is configured to be initially electrolessly-deposited on the dielectric layer and then electroplated onto the dielectric layer and then the copper layer is configured to be plated with a metal selected from a group consisting of tin, lead/tin combination, silver, and gold. The metal pad can be configured to contact the proximate end of the conductive wire to generate a robust contact with a micro-strip line of the circuit board. The supporting bracket and the

17

distal end of the conductive wire can provide a robust contact with the circuit board. The non-conductive tapered core can have a tetrahedron shape. The non-conductive tapered core can have a triangular pyramid shape. The non-conductive tapered core can have a multi-dimensional polygonal shape. The non-conductive tapered core can be composed of powdered iron. The assembly can be configured to reduce insertion loss in a frequency range from below 10 KHz to over 100 GHz. The dielectric material can be manufactured from a material selected from a group consisting of: a hydrocarbon ceramic loaded glass, ceramic, ceramic reinforced glass or PTFE-based materials, PTFE materials reinforced with glass fibers, hydrocarbon ceramic composites, and rigid plastic.

Example embodiments of the methods and components of the current subject matter have been described herein. As noted elsewhere, these example embodiments have been described for illustrative purposes only, and are not limiting. Other embodiments are possible and are covered by the invention. Such embodiments will be apparent to persons skilled in the relevant art(s) based on the teachings contained herein. Thus, the breadth and scope of the current subject matter should not be limited by any of the above-described exemplary embodiments, but should be defined only in accordance with the following claims and their equivalents.

What is claimed is:

1. A method of manufacturing an ultra-wideband assembly for placement in an electrical circuit having a circuit board with a conductive micro-strip line, comprising:

providing a non-conductive tapered core,
said core including
an outer surface;
a distal end; and
a proximate end,
said distal end being larger than proximate end;

providing a conductive wire having a proximate end and a distal end and winding said conductive wire about at least a portion of said non-conductive tapered core;

wherein

said proximate end of said conductive wire extends away from said proximate end of said non-conductive tapered core and is being conductively coupled to said micro-strip line of said circuit board;

said distal end of said conductive wire extends away from said distal end of said non-conductive tapered core;

said conductive wire contacts at least a portion of said outer surface of said non-conductive tapered core;

providing a supporting bracket for coupling to said non-conductive tapered core;

said supporting bracket having

a base portion; and
a core attachment portion;

said base portion is being conductively coupled to said circuit board;

said core attachment portion is being coupled to said distal end of said non-conductive tapered core and is further being conductively coupled to said distal end of said conductive wire;

while being coupled to said non-conductive tapered core, said supporting bracket is configured to dispose said non-conductive tapered core at a predetermined angle to said circuit board.

18

2. The method according to claim 1, wherein said predetermined angle is in a range of greater than or equal to 10 degrees and up to substantially 90 degrees with respect to said circuit board.

3. The method according to claim 1, further comprising providing a dielectric layer configured to be disposed on top of at least a portion of said conductive wire being wound on said non-conductive tapered core, said dielectric layer being disposed substantially near said proximate end of said non-conductive tapered core.

4. The method according to claim 3, further comprising providing a metal pad;
coupling said metal pad to said dielectric layer at said proximate end of said non-conductive tapered core.

5. The method according to claim 4, wherein said metal pad is configured to contact said proximate end of said conductive wire to generate a robust contact with a micro-strip line of the circuit board.

6. The method according to claim 3, wherein said dielectric layer is configured to extend away from said outer surface of said non-conductive tapered core.

7. The method according to claim 3, wherein said dielectric layer has a thickness in range between approximately 0.004 inches to approximately 0.035 inches.

8. The method according to claim 7, wherein said dielectric material is a hydrocarbon ceramic loaded glass.

9. The method according to claim 3, wherein said metal pad has a thickness in the range of approximately 0.0005 inches to approximately 0.003 inches.

10. The method according to claim 3, wherein said metal pad includes a copper layer, whereby the copper layer is configured to be initially electroless-deposited on said dielectric layer and then electroplated onto said dielectric layer and then said copper layer is configured to be plated with a metal selected from a group consisting of tin, lead/tin combination, silver, and gold.

11. The method according to claim 3, wherein said supporting bracket and said distal end of said conductive wire provide a robust contact with said circuit board.

12. The method according to claim 3, wherein the dielectric material is manufactured from a material selected from a group consisting of: a hydrocarbon ceramic loaded glass, ceramic, ceramic reinforced glass or PTFE-based materials, PTFE materials reinforced with glass fibers, hydrocarbon ceramic composites, and rigid plastic.

13. The method according to claim 3, wherein said dielectric layer is manufactured from low loss dielectric material having a low dielectric constant.

14. The method according to claim 1, wherein said non-conductive tapered core has a tetrahedron shape.

15. The method according to claim 1, wherein said non-conductive tapered core has a triangular pyramid shape.

16. The method according to claim 1, wherein said non-conductive tapered core has a multi-dimensional polygonal shape.

17. The method according to claim 1, wherein said non-conductive tapered core is composed of powdered iron.

18. The method according to claim 1, wherein the assembly is configured to reduce insertion loss in a frequency range from below 10 KHz to over 100 GHz.

* * * * *